

# **Guide to Dual Flight Operations Preparing & Releasing a Dual Flight Bar**

**Vaisala RS92-NGP®      Sippican B2®**

## **Attachment C**

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National Oceanic and Atmospheric Administration  
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Field Systems Operations Center/Observing Systems Branch**

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## ACRONYMS AND ABBREVIATIONS

TERMS	DEFINITION
MicroART	Microcomputer Automatic Radio-theodolite
BILS	Balloon Inflation Launch Shelter
CDU	Control Display Unit
DCA	Data Control Assembly
FSD	Frequency Setting Device
GPS	Global Positioning System
hPa.	Hectopascal
IF	Intermediate Frequency
KHz	Kilohertz
LOS	Line-Of-Sight
Mb	Millibar
PSI	Pounds Per Square Inch
IB	Inflation Building
MHz	Megahertz
MSL	Mean Sea Level
NCDC	National Climatic Data Center
NEC	National Electrical Code
NFPA	National Fire Protection Association
NOTAM	Notice to Airman
PITS	Protocol Interface Tests Suite
RF	Radio Frequency
RRS	Radiosonde Replacement System
RSOIS	Radiosonde Surface Observing Instrument System
RTS	Radiosonde Test Stand
RWS	RRS Workstation
SDM	Station Duty Manual
SFSC	Sterling Field Support Center
SPS	Signal Processing System
SPSS	Statistical Package for the Social Sciences
TRS	Telemetry Receiving System
UHF	Ultra High Frequency
UPS	Uninterruptible Power Supply
UTC	Coordinated Universal Time
WMO	World Meteorological Organization

## **1.0 Introduction**

The Upper Air Data Continuity Study (DCS) is useful for investigating the relationship between climate variation and change due to measurement error. To replace the antiquated Microcomputer Automatic Radio-theodolite (MicroART), a system that has been in operation since the late 1980s, new Global Positioning System (GPS) radiosondes have been introduced. The National Weather Service (NWS) upper air network has witnessed a significant impact on operations from the implementation of the new GPS radiosondes due to sensor changes for temperature, pressure and relative humidity measurements. Because these have differing characteristics than other current radiosondes, the DCS is pertinent in assessing the sensors in a variety of climatic and meteorological conditions.

The DCS flight configuration will consist of flying two radiosondes on the same balloon during the 00z and 12z synoptic windows once a week. The day that flights will occur will be left up to the site's discretion; however, once DCS flights begin, the site will continue with that scheduled day. It is suggested that the site conduct operations on a Tuesday, Wednesday or Thursday in order to alleviate issues with holidays or vacations that often occur on a Monday or Friday. These flights must be conducted as precisely as possible in order to accurately assess the sensors' behavior. The purpose of this document is to guide observers through the steps to properly assemble and release a dual flight bar in order to complete an accurate and successful flight using the Vaisala RS92-NGP and Sippican B2 radiosondes.

## **2.0 Procedures**

The following procedures detail the prescribed order of operations to be conducted when performing a dual flight. More specific instructions can be found in the Guide to Dual Flight Operations: Performance Checklist for Vaisala RS92-NGP and Sippican B2.

- 1.) Equipment Warm-Up**  
Powering on Uninterruptible Power Supply (UPS) and other hardware to allow for warm-up operations
- 2.) Balloon Inflation and Train Assembly**  
Preparing balloon and train assembly for flight
- 3.) Radiosonde Preparation**  
Preparing radiosondes according to vendor documentation
- 4.) Ground Equipment Preparation Procedures**  
Completing hardware status checks, pre-release information, instrument baseline and antenna positioning
- 5.) Release Site Processes**  
Final train preparations, obtaining launch approval, and possible repositioning of antenna
- 6.) In-Flight Procedures**  
Ensuring release was auto-detected, monitoring the flight using displays and plots, transmitting messages
- 7.) Archiving & Post-Flight Test Activities**  
Uploading compressed flight data to FTP site for the National Climatic Data Center (NCDC)

## 2.1 Equipment Warm-Up

The observer should begin preparing for a dual flight at least 45 minutes in advance in order to allow adequate time for the workstations and tracking systems to warm-up. Specifically with the TRS, warm-up operations could take 30 minutes, especially in colder temperatures. This also provides the observer with more time to troubleshoot the hardware in the case a problem arises.

- Turn on both the RRS Workstation (RWS) and MicroART computer. Log into the RWS workstation using your individual Username and Password.
- Ensure the GPS repeater is turned on.
- Open the RWS.NET program and click OK in the NOAA Security Warning Window after reading the message.



Figure 1. NOAA Security Warning Window

- Select “Run a Live Flight” and click YES when prompted to turn on the UPS. The UPS provides uninterrupted power to the TRS and SPS. A green checkmark in the Hardware Display will indicate the UPS has been successfully powered on.

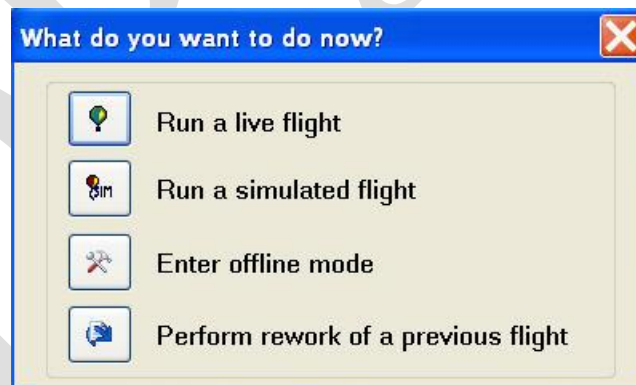
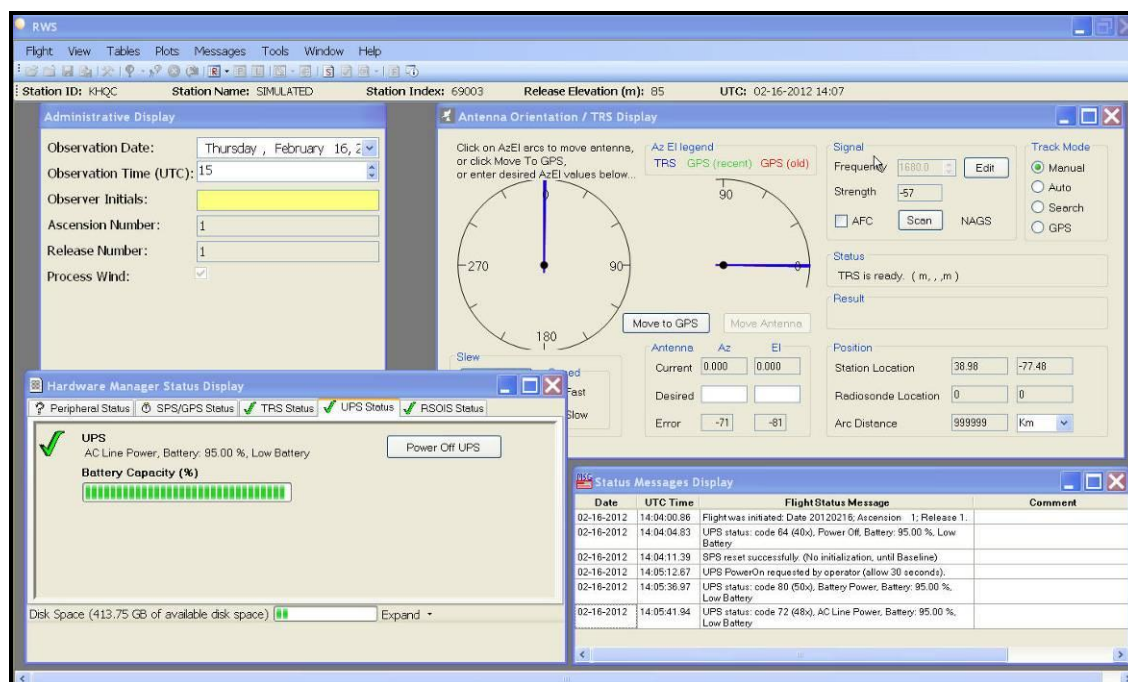


Figure 2. RWS Action Selection Window

- Allow the Telemetry Receiving System (TRS) to perform Motor Warm-Up Operations and/or Initialization. This is dependent upon ambient temperatures. These processes are reflected in the TRS Display, Status Messages and Hardware Status Manager.

**\*Important: Allow 30 minutes prior to Baseline for the TRS to warm-up. This time is necessary, especially in colder temperatures. The TRS Status Line on the Antenna Orientation Display and the Status Messages will indicate “TRS is Ready” when warm-up and initialization is complete.\***



**Figure 3. RWS Windows after selecting "Run a Live Flight"**

- When prompted, set the date and time for the MicroART. Proceed through the MicroART Virus Scan.
- Turn off Standby and Low Sensitivity on the Data Control Assembly (DCA).

## 2.2 Balloon Inflation and Train Assembly

Pre-observation procedures are an important component of successful upper-air operations. The care taken in preparing for an observation decreases the likelihood of unsuccessful or missed observations due to defective parts or from using improper procedures. The observer should be aware of changing weather conditions that may affect the decision on train components used for the flight, the amount of gas, and release obstacles that may result from such conditions.

The flight bars provided by the Sterling Field Support Center (SFSC) are six feet in length to allow adequate spacing between the radiosondes. This prevents contact with one another mid-flight. Radiosondes are then attached three feet below the bar via the pre-knotted string to reduce solar influences. The entire length of the bar is taped for added strength and additional tape has been applied to the ends of the bar to protect the quality of the Styrofoam from the weight of the instruments.

- Begin inflating an HM-32 1200 gram balloon provided by the Sterling Field Support Center (SFSC)
- Determine the additional weight needed for the dual flight depending on the present weather conditions and those expected at the time of release. The following chart can assist in determining this weight based on the prevailing weather type and intensity:

Precipitation		Frozen Precipitation	
Intensity	Additional Weight (g)	Intensity	Additional Weight (g)
Light Rain	1100-1300 g	Light Frozen	1200-1400 g
Moderate Rain	1300-1500 g	Moderate Frozen	1400-1500 g
Heavy Rain	1500-1800 g	Heavy Frozen	1700-1900 g
<b>No Precipitation: 800-1000 g</b>			

**\* This table should only be used as a guideline for applying additional weight since ranges are heavily dependent upon location, temperature variations, and balloon manufacturing procedures. It is important to monitor the flight to ensure SFC-Term ascent rates of 275-350 m/min are being achieved.\***

- For actual lift calculations, the following table lists the nominal weights for the train assembly:

Components	Weight (grams)
RS92-NGP Radiosonde	305
B2 Radiosonde	475
Spreader Bar Assemble	214
Parachutes (2)	150
<b>Total</b>	<b>1144</b>

- To prepare the train using two parachutes, first tie a seven foot length of double strand cord to the loop on the top parachute, leaving free the other end of the string. This will be used to tie the balloon neck. Repeat this step again, except tying the cord to the loop of the bottom parachute. This cord should then be knotted securely to the string extending down from the top parachute.



**Figure 4. Observer tying top and bottom parachutes together**



**Figure 5. Knot joining top and bottom parachutes**

- To avoid temperature contamination from the balloon wake, the recommended train length for test flights is 30-37 meters. However, this may not be practical under certain wind and weather conditions. Based on these conditions at release, adjust the remainder of the train so the total length meets standards as indicated below, securing the flight train to the bottom of the second parachute:

<b>Wind Speed (knots)</b>	<b>Train Length (meters)</b>	<b>Train Length (feet)</b>
0-5	37	120
6-10	27	90
10-15	23	75
>15	Consider canceling DCS Flight	

*Note: The total train length (70-120 feet) is the distance extending from the balloon neck to the top of the flight bar. It does not describe the length from the bottom of the second parachute to the top of the flight bar.*

**\*The minimum train length should not be less than that which the NWS considers acceptable for operations (21 meters). Trains less than the prescribed length should never be used since this increases the risk of the radiosonde being too close to the radiation environment of the balloon or from encountering the balloon's wake as it ascends. Erroneous data may result from these occurrences. \***

- SFSC will provide flight bars with the flight bar assembly attached. Position and secure the flight bar on the Radiosonde Test Stand (RTS) and tie the train assembly to the end of the string extending from the top of the bar.



**Figure 6. Tying flight train to flight bar**



**Figure 7. Knot connecting flight train and flight bar**

- **When Applicable:** Because the flight train is longer and larger in mass, two glow sticks should be used for a nighttime dual release. Attach one glow stick to the end of the second parachute with the small strings that extend from the knot. The second glow stick should be tied to the bottom of the flight train where it is connected to the flight bar.
- Once the balloon has finished filling, complete the flight train by tying the top parachute to the balloon neck, allowing a minimum of six feet between them. Ensure the flight train is complete elsewhere and inspect tie points to verify all knots are tight.



Figure 8. Completed flight train

**\*Warning:** Because some inflation bays are lower than others and additional weights increase its size, be mindful when filling the balloon and preparing it for release so that it does not touch the ceiling. This can puncture the balloon, creating a leak, or pop the balloon completely. \*

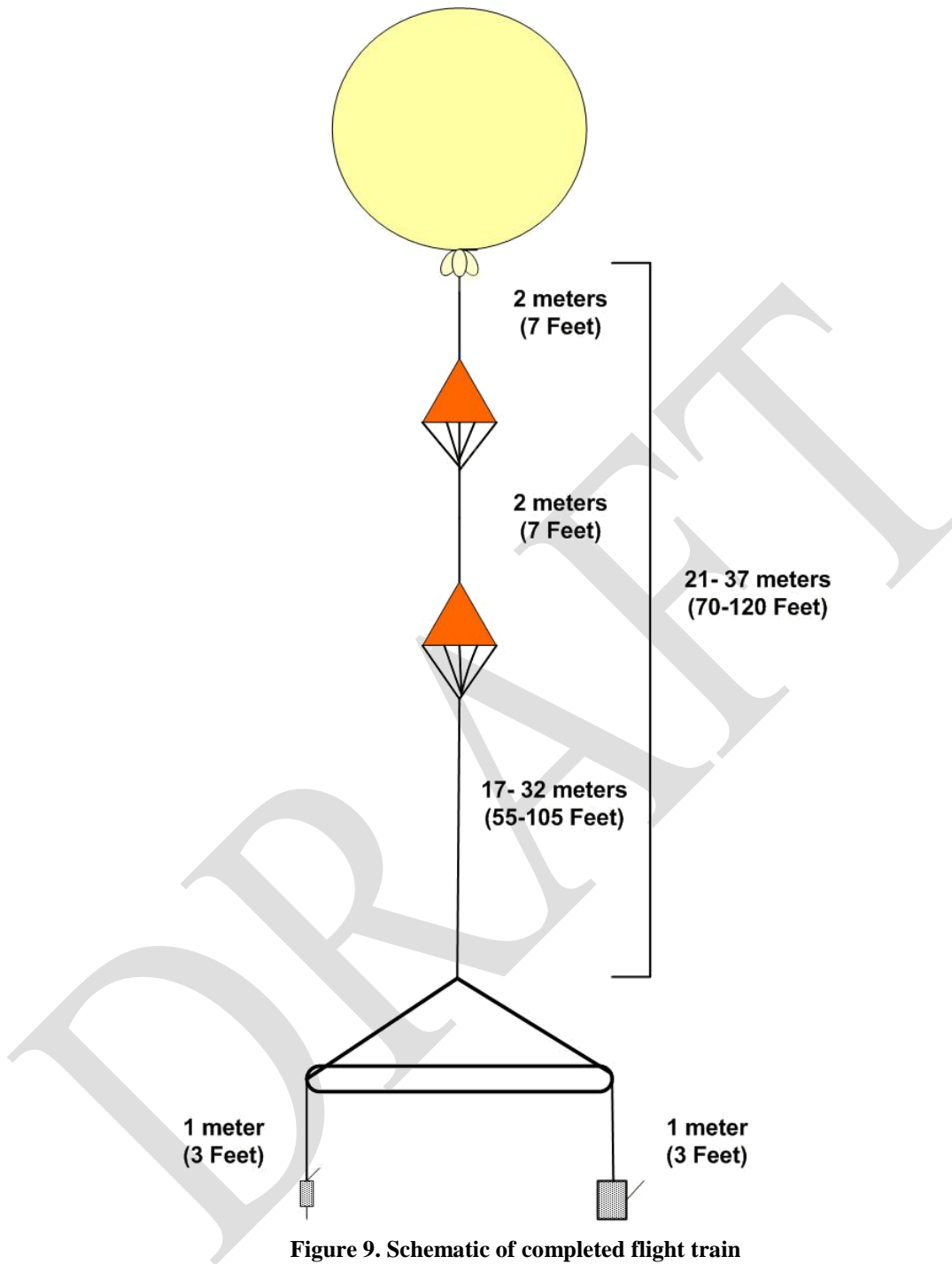


Figure 9. Schematic of completed flight train

### 2.3 Radiosonde Preparation

Using the provided radiosonde and battery preparation instructions and NWS standard procedures, prepare the radiosondes for flight. It is pertinent that the instruments be handled carefully so that contamination to the sensors by the observer can be alleviated. Mishandling the unit could also compromise the integrity of the data during flight.

Setting the radiosonde frequencies is one of the most critical parts of the preflight operation procedures. Because the frequency on the Sippican B2 radiosonde could drift upwards during the flight, SFSC recommends this radiosonde to be set to 1680 megahertz (MHz). To compensate, it is recommended to adjust the frequency of the Vaisala RS92-NGP radiosonde to 1676 megahertz (MHz). This should avoid the B2 radiosonde signal from interfering with that from the RS92 since the RS92 should not drift by more than 0.1 MHz. A Frequency Setting Device (FSD) will be supplied with the Vaisala radiosondes and is used not only to set the frequency, but to burn contaminants off of the sensors before the flight. To use this device, a cable is plugged into the bottom of the radiosonde and the frequency is selected from simple button options. These button options are channels with corresponding frequencies, including 1676, 1678, 1680, and 1682 MHz. The digital screen will read that the “Radiosonde is Ready” upon completion.

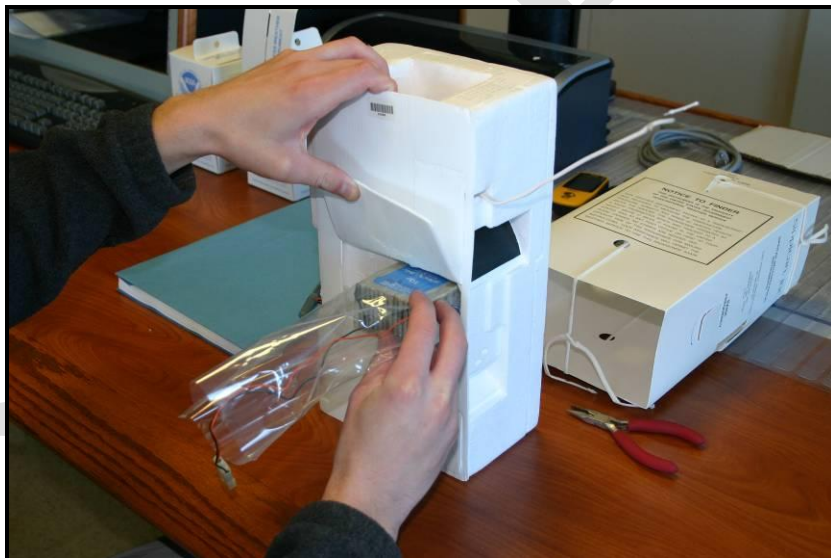


**Figure 10. Vaisala RS92-NGP on Frequency Setting Device (FSD)**

While inside, especially during the baseline process, it is important to keep the radiosondes at least six feet apart. This will help to eliminate interference between frequencies. Although the radiosonde batteries should not be plugged in until ground equipment preparation procedures have been completed, it is necessary to plug in and lock on to the B2 radiosonde prior to powering on the RS92-NGP. This will help to prevent the ART from locking onto the RS92-NGP signal. It is also suggested that the station record the actual frequency used for both instruments in case an operational second release is required. If a second release is required, the observer should select a frequency not previously used to avoid cross-contamination of signals.



**Figure 11. Plugging in the RS92-NGP battery**



**Figure 12. Preparing the Sippican B2 battery**

## **2.4 Ground Equipment Preparation Procedures**

Once the flight train and radiosondes have been prepared, the ground equipment procedures must be completed prior to releasing the balloon:

- Position the TRS antenna within a few degrees of the baseline point using the Antenna Display Window. Complete the Administrative and Equipment Displays then click Next;
- Position the ART antenna within a few degrees of the documented target antenna. Turn the target antenna switch on and allow the antenna to lock on the target antenna by pressing Far Auto;

- From the ART Options Menu, select ART Observation. When prompted, complete the Administrative Data and Flight Equipment Data screens;
- In RWS, set the radiosonde frequency in the TRS Display after placing the TRS in Manual Track Mode. This can be done by clicking Edit, entering the frequency, clicking Set and turning AFC ON;
- Complete the VIZ Radiosonde Data screen and insert the appropriate Calibration Diskette into the drive when prompted; and
- At this time, complete the radiosonde procedures by preparing and activating batteries.

**\*Ensure that the Sippican B2 and Vaisala RS92-NGP radiosondes are no closer than six feet from one another during the baseline process. It is important to plug in and lock on to the B2 radiosonde before plugging in the RS92-NGP. If this is not completed, it is likely the ART will lock onto the RS92-NGP.\***

- Complete the Surface Observation Display and Surface Data screen in both RWS and MicroART using the most recent surface observation. This should be completed no more than 10 minutes prior to release. Confirm that batteries are plugged in before beginning baseline.
- Continue to the cross-check message screen in MicroART to review any inconsistencies. Insert the Log Diskette and press enter when ready. Adjust the Azimuth to the appropriate angle to prepare for baseline and acquire a radiosonde signal. Check the AFC meter to ensure the transmitter signal is being received clearly. Press Standby once this is complete.
- In RWS, click Next from the Surface Observation Display to begin the baseline process. In MicroART, press Enter to begin the baseline check. Once the readings become stable, compare the instrument's readings against the surface conditions entered.

**\*Once the Baseline Display window has appeared and started populating, wait at least five minutes before accepting. Time is needed for the sensors to stabilize and for a proper pressure correction to be calculated. Baseline MUST be accepted before releasing the balloon.\***

*Note: Ensure pressure sensor has stabilized prior to accepting baseline. The battery and pressure sensor must warm-up. If the pressure sensor is not warmed up, pressure discrepancy may create height errors.*

- If the pressure discrepancy is within  $\pm 3$  hPa for the Vaisala RS92-NGP radiosonde and the temperature and relative humidity values look reasonable, click Accept. Do not complete baseline without GPS. "Waiting for Release" will then be displayed on the RWS screen.
- For the MicroART, press F10 to complete baseline. After the baselining tests are complete, accept the radiosonde by clicking enter if the pressure discrepancy is within  $\pm 5$  hPa. The Antenna Lock screen will display \*\*\*RADIOSONDE READY FOR RELEASE\*\*\*.

- Before proceeding to the release site, put the TRS in Manual Track Mode and direct the Azimuth/Elevation to where the radiosonde is expected to travel. For the ART, ensure that Standby is illuminated and move the Azimuth/Elevation to where the radiosonde is expected to travel. Confirm that the Track Mode for the ART is set to Manual.
- The TRS is 180 degrees out from the wind direction. Because they can easily be confused with the ART, the following chart lists pressure discrepancy thresholds and orientation of the antenna before and during the flight:

	<b>Pressure Discrepancy</b>	<b>Antenna-North</b>
<b>TRS</b>	Vaisala RS92-NGP: $\pm 3$ hPa	Azimuth of 0 degrees
<b>MicroART</b>	Sippican B2: $\pm 5$ hPa	Azimuth of 180 degrees

## 2.5 Release Site Processes

- Upon arriving at the release location, tie the radiosondes to the assembled flight bar, first attaching the Vaisala RS92-NGP radiosonde to the string that has a knotted loop. The loop should be slipped through the gaps in the eyelet. Following this, the B2 radiosonde should be tied on to ensure that it hangs at the same height as the RS92-NGP. This enables the radiosondes to measure the same atmospheric column, yielding a more precise data comparison.



Figure 13. RS92-NGP hanging from knotted loop on assembled flight bar



**Figure 14. Sippican B2 tied to assembled flight bar**



**Figure 15. Completed flight bar with RS92-NGP and Sippican B2 radiosondes**

- Visually inspect the release zone and the anticipated path of flight for any obstacles or dangers. Check the flight train's integrity and ensure radiosondes are secure on the flight bar.

- If within five nautical miles of an airport, call the airport control tower and request approval to release the balloon.
- When positioning for release, the individual holding the spreader bar assembly should be downwind from the individual handling the balloon. Keep the bar and radiosondes as level as possible during the release.
- As the observer with the balloon moves from the inflation bay, he/she should be maneuvered upwind in order for the balloon to pass overhead of the individual holding the bar.
- If possible, the distance between the observers should be such that the string has no slack and the balloon is released. This will help to prevent the flight train from becoming tangled. The observer with the balloon should be facing the observer holding the bar. This will allow for better control of the flight bar when the balloon is released depending on dominant wind conditions.
- While one observer releases the balloon, another observer should keep a loose grip on the flight bar, cradling it above and away from their body. As they move in the direction of the balloon, the bar will be lifted by the balloon out of the observer's hands.



**Figure 16. Preparing for balloon release with flight bar**



**Figure 17. Balloon passing overhead of observer with flight bar**



**Figure 18. Release of flight bar**

- Once the balloon is released, the observer should then hit the release pulse as the other observer lets go of the bar. The ART timed release may be used, but a best effort should be made to time when the spreader bar will begin its ascent.
- After release, the observer can use the TRS remote Control Display Unit (CDU) to verify the frequency has not shifted for the Vaisala RS92-NGP. Double check to ensure the antenna is positioned to the appropriate azimuth and elevation and that AFC is on. After returning to the workstation, check to make sure release was detected. RWS should automatically detect release. Update the Surface Observation and release time as necessary.
- Upon returning to the RWS workstation, verify the TRS signal strength is acceptable. If GPS is being received, place the Antenna into Search mode in the Antenna Orientation Display. Auto track mode will automatically be selected once the TRS has detected the strongest signal. The TRS can also be pointed towards the balloon in the Azimuth/Elevation window by inputting values and clicking Move Antenna or

Move to GPS. **Do not click Move to GPS if GPS data is unavailable as this may cause the software to freeze.**

- To verify that release has been detected and logged correctly, check the first pressure data point below the red line in the Received PTU Tabular Display. This point should have a pressure equal or less than the release pressure shown in the Surface Observation at release. Check the Geopotential Height and ensure it increases with time.
- For the Sippican B2, open the ART remote release panel and turn up the speaker volume to check for a clean signal. Initiate release, then adjust the position to acquire and maintain a lock to the radiosonde. Turn Auto Track and AFC On. After returning to the PC, enter the time the antenna locked onto the radiosonde and delete position data up to the point lock-on occurred. Verify the Surface Observation screen as necessary.
- Monitor the B2 signal strength and adjust the Azimuth and Elevation if necessary to maintain a lock onto the radiosonde. The audio should be utilized to verify accurate instrument tones and to check for interference or signal loss.

## 2.6 In-Flight Procedures

During the flight, to the extent possible, site personnel will monitor the flight for potential problems and ensure the validity of the test. Any problems should be documented and the site should notify the RRS Help Line. Since the RWS system acts as the operational system, it is imperative the flight be quality controlled in an operationally acceptable manner. With regard to the MicroART flight, the operator may quality control the data if time permits. However, it is not necessary since office operations will always take precedence.

Monitoring the flights using displays and plots can assist in ensuring the flight is successful. A variety of parameters can be plotted, including temperature, winds and relative humidity. This data should be quality controlled throughout the flight in order for the observer to determine if edits are necessary, especially in RWS. Periodically checking the Check and Status Messages and incoming meteorological data also assists the observer in verifying ascent rates are realistic. These averages should be approximately 5 meter/sec or 275-350 meter/min. Furthermore, confirm RADAT and Coded Messages appear to be correct, especially before message transmission is initiated.

Upon completion of the flight, both RWS and MicroART will detect termination. Transmit all remaining messages before closing each program. In RWS, the flight must be closed before the observer can exit RWS. The UPS should be turned off when prompted. Although the flight has been closed, it can still be opened in Rework if additional edits are desired. For MicroART, exit the ART Observation option by typing EXIT at the ?> prompt. Remove the Log diskette from the diskette drive and insert the Store diskette currently in use.

## **2.7 Archiving & Post-Flight Test Activities**

After each test flight, the data from both systems will be archived in a manner consistent with established site procedures. Personnel will make every effort to complete the Data Continuity Input Form immediately after the flight. If this is not possible, it should be completed by the end of the current shift. Additionally, when the B29 form is completed, the remark “DCS flight” should be noted in the Remarks section. Other remarks may be entered at the discretion of upper air personnel. The site should contact SFSC if a significant event occurred which may have a negative impact on the DCS flight.

## **NWS Sterling Field Support Center**

The NWS Sterling Field Support Center serves to provide operational assistance to National Weather Service field personnel with questions that pertain with the operation of a new RWS system, including pre-flight and flight assistance during synoptic soundings. The SFSC assists users in order to ensure continuity in understanding of the RWS system and quality data collection among all operating deployment sites.

**Hours of Operation**  
M-F 10:00-02:00 UTC

**Contact**  
(703) 661-1268 (703) 661-1293